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71 CEARA ENGINEERING LIMITED

FULL NAME(S) OF INVENTOR(S)

72 JOHN WORKMAN

TITLE OF INVENTION

54 METAL PRESSING AND STAMPING

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FULL NAME(S) OF APPLICANT(S)/PATENTEE(S)

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APPLICANTS SUBSTITUTED:	DATE REGISTERED
71	

ASSIGNEE(S)	DATE REGISTERED
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TITLE OF INVENTION

54 METAL PRESSING AND STAMPING

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61	
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A & A P 202

[redacted] Metal pressing and stamping"

This invention relates to improved processes and apparatus for the production of components from sheet metal by pressing or stamping.

Certain applications of such components, for example electric motor laminations and components for food and drinks cans, involve extremely large production runs. In these circumstances, the maximising of utilisation of the starting material and minimising of scrap is important to the economics of production. One object of the present invention is to provide improvements in this.

Another object of the invention is to reduce handling of the materials, whether manual or by means of automatic transfer machines, robots and the like and to allow presses to run continuously for relatively long periods of time.

Accordingly, one aspect of the invention provides a method of cutting components from continuous metal strip, comprising:

providing the strip with periodic repetitive features at axial spacings corresponding to successive component positions, and

effecting cutting of the strip in a manner closely defining the component positions;

characterised by effecting wavelength adjustment immediately prior to or during cutting to produce correspondence between the feature spacing on the strip and a length dimension of the cutting means.

In preferred embodiments, the cutting means is a progression press tool, and said length dimension is the pitch between successive stages thereof.

The adjustment may be provided by forming weakened zones in the strip between component positions (e.g. slots punched during the profiled slitting of the strip),

and subjecting the strip to differential drawing to widen said weakened zones. Alternatively, such adjustment may be effected thermally by applying heat to the strip shortly before entry to the press tool.

The invention also provides, in another aspect, a method of feeding a press tool having a plurality of pressing positions starting with strip material which is of substantially greater width than the dimensions of the components to be produced, the method comprising feeding the strip forward stepwise and, between successive forward steps, indexing the strip sideways to allow the or each tool to operate successively on the strip across its width. The forward feed direction and sideways indexing direction may be oblique to each other to permit optimum nesting of components. The press may contain progressive tooling along said sideways direction.

Embodiments of the invention will now be described, by way of example only, referring to the accompanying drawings, in which:

Fig. 1 is a plan view illustrating the formation of strip for use in the invention;

Fig. 2 illustrates a first stage of another method of forming strip for use in the invention;

Fig. 3 illustrates the following stage of the same method;

Figs. 4 and 5 show in detail alternative methods of carrying out the joining shown in Fig. 3;

Fig. 6 is a perspective view of a pair of rolls which may be used in the arrangement of Fig. 1;

Fig. 7 is a perspective view of a pair of steerable rolls which may be used instead of the shaped rolls of Fig. 6;

Fig. 8 is a perspective view of a pair of steerable cutting shears which may replace the rolls of Fig. 7;

Fig. 9 is a perspective view of a slitting machine embodying the invention and using the steerable cutters of Fig. 7;

Fig. 10 is a plan view showing in detail part of a slit strip used in another embodiment;

Fig. 11 is a perspective view illustrating slit strip being fed to a progressive or blanking die set;

Fig. 12 shows a typical sequence of punching steps on the slit strip;

Fig. 12A is a diagrammatic side view of a modified pair of cutter wheels;

Fig. 12B is an end view of a modified pair of cutter wheels;

Figs. 12C-12E are diagrammatic side views illustrating the invention applied to processes involving printing or the like;

Fig. 13 is a perspective view of a press feed system for use in a second major aspect of the invention;

Fig. 14 is a perspective view of a modified feeding apparatus for two strips;

Figs. 15 and 16 are side views of alternative feed systems using the apparatus of Fig. 14;

Fig. 17 is a diagrammatic sectional plan through the horizontal centre plane of a die set for use in conjunction with the foregoing feed systems;

Fig. 18 is a similar view of a die set for manufacturing delicate components;

Figs. 19 to 24 are views similar to Fig. 17 showing alternative forms of die set; and

Fig. 25 is a diagrammatic plan view of an alternative strip feeding means.

One aspect of the invention is particularly relevant to the supply of material to progression or blanking tooling. This is conventionally done by uncoiling stock strip, slitting it to appropriate widths, and feeding the slit strip to one or more progression tooling machines. This leads to a high degree of waste, typically about 21%, when punching shapes which are approximately circular.

Referring to Fig. 1, in an arrangement for use with invention, steel strip 2 is fed from a supply coil 1 between edge guides 3. The strip 2 is slit by rotary cutters 5 mounted on shafts 4, the cutters 5 having interengaging side cutting profiles arranged to slit the strip in a configuration conforming to the components 10 to be subsequently punched. Fig. 1 shows as an example circular components 10 nested between slit edges 9. The strip is moved by draw rollers 6. The slitting pattern may be monitored or controlled by a feedback arrangement, for example by photocell arrays positioned at 7 and 8, to detect irregularities produced by, for example, slippage at the draw rollers 6. A shear 11 for producing slots 12 may be included, for purposes which will be described. If desired, the edge of the strip may be slit off as shown at 13 to give a balanced-profile slit strip.

The arrangement of Fig. 1 thus gives a series of long strips with non-straight edges, which can be fed directly to separate progression tooling machines or coiled for subsequent use. The nesting of the component profiles can reduce the overall scrap rate to typically 11-12%.

It is also possible (not illustrated) to slit a single broad strip into two sets of profiled strips of differing wavelength, the sets being separated by a straight slit. This can provide the optimum utilization of a broad coil into the best ratio for differing demands albeit that the nesting in each set is less than maximum.

Similar strips can be produced using simpler apparatus by the method illustrated in Figs. 2 and 3. The stock strip 2 is unwound from the supply coil 1 and sheared obliquely in the pattern shown in Fig. 2. The sheared sheets 14 are then joined endwise as by

spotwelding at 15 to produce a continuous strip.

Figs. 4 and 5 show the joins in greater detail. The sheets 14 are joined by spotwelding at 18 or by seam welding between these points. The end profile 16 shown in Fig. 4 gives good joint strength and maximum space for subsequently punching pilot holes 19. In Fig. 5, a straight end profile 17 is used which is simpler to produce but gives less strength and space only for smaller pilot holes 20.

Reverting to the profiled longitudinal slitting of Fig. 1, Fig. 6 illustrates suitable slitting shear cutters 5 with sideground profiles 21,22 shaped to produce the desired slit. As an alternative these slits could be produced by plane-sided cutter wheels whose cutting axis is steerable. Such an arrangement is shown in Fig. 7, in which cutter wheels 24,26 are rotatably mounted on axles 27 journalled in housings 23,25 which can be rotated via ring gears 28. In a modification (Fig. 8) there could be similarly mounted changing-shear wheels 30,31 arranged with material thickness clearances 32,33; this would be advantageous if sharp corners are to be produced to either hand.

Fig. 8A shows an arrangement similar to Fig. 7, except that the axles 27 are at an angle to allow the use of bevelled-edge shearing wheels 24A,26A. This allows sharp turns to either hand without being limited to a fixed wavelength as in Fig. 8.

Fig. 9 shows an exemplary slitting apparatus using such steerable wheels. Three sets are mounted on upper and lower carriages 35 which oscillate on guides 36, each housing 23,25 being mounted in a bearing 34 secured to the carriage 35 with an interposed packer(s) 48 to set the wave spacing. The ring gears 28 are engaged by steering racks 38 mounted on upper and lower steering carriers 37. Packers 49 are provided

corresponding to the packers 48.

The arrangement is oscillated by means of a cam drive. Cam 41 is rotated by cam motor 42 to drive cam follower 40 pivoted on a fulcrum bar 50. The motor 42 can be adjusted axially to vary the throw of the follower. The follower 40 drives the lower steering carrier 37 via a pin-and-slot link, the slot 43 only being shown. Further cams and links (not shown) driven by the motor 42 similarly reciprocate the other parts via slots 43,44,46. The members 45 are counterweights driven in antiphase to the cutters and their carriages; additional weights 47 may be added to compensate for additional cutter units which may be secured via bolt holes 53.

A steerable shear arrangement similar to Fig. 9 could be achieved by numerical control of the individual wheels, rather than the mechanical linkages shown.

It will also be noted from Fig. 9 that the slit strips are led off alternately upwardly and downwardly, to enable them to be coiled without the profiled edges interfering with each other.

The various arrangements described thus far result in a continuous strip with profiled edges.

Such strip <u>per se</u> has been known hitherto, and has been used in producing relatively simple components where a high degree of accuracy is not required, for example in producing can ends by blanking. However, continuous profile-edge strip has not previously been used for feeding progression tooling. It is believed that one reason for this is that the very high degree of accuracy required in maintaining the profiled strip in registry with the punching dies could not be achieved. This accuracy can be degraded by, for example, changes in ambient temperature or temperature changes in coiled strip which has been stored externally.

Means are provided for adjusting the wavelength of the strip (that is, the axial dimension between repetitive features such as the edge profile) to compensate for input material condition (such as temperature or tension) other than standard which would affect the subsequent spacing of the features.

Reverting to Fig. 9, the wavelength of the strip can be matched to a standard required. A feedback detector such as photocell array 7 is connected to a control circuit 100 controlling the cam motor 42. The feedback system may conveniently include other inputs for sensing conditions affecting length, such as a temperature sensor indicated at 106 for sensing the temperature of the incoming strip. The tension of the strip could also be monitored. The feedback arrangement is not shown in detail since suitable circuits will be readily apparent to those skilled in the art.

The invention additionally provides means of finely adjusting the wavelength immediately before pressing, as will now be described.

Fig. 10 shows a profiled strip which has been sheared, as described in relation to Fig. 1, to produce slots 12. Thus the position of each component 10 is joined to the succeeding one only by three narrow tabs of material. In this way, fine adjustment of position on feeding into a press can be achieved by pulling adjacent sections somewhat apart, widening the slots 12, e.g. by differentially driven pairs of rolls, or by fixed stops in conjunction with the normal feed mechanism for the press. The weakened portions may be provided only periodically, rather than between each component location. The same technique can be applied to the strips of Figs. 2-5, with the welded joints acting as the weakened portions. In those embodiments, the average wavelength can also be controlled by altering

the weldgap when assembling the profiled strip.

Other means of mechanical wavelength adjustment are possible. For example, the strip could be stretched by pulling on the profiled edges, or by pressure applied in the thickness direction (squeezing or hammering).

Another means of achieving the same effect is illustrated in Fig. 11. The strip is fed to a conventional die set 54 by a conventional strip feeder 55. Fine control of the strip "wavelength" is achieved by heating the strip by infrared lamps as shown at 57 or by any other suitable means such as resistance elements, microwave energy, or eddy current heating. The heat source should be of low thermal inertia to allow rapid alteration. The heating means is controlled by feedback from a monitor 58 such as a photocell array. The positions of the strip feeder 55 and lamp 57 could be reversed.

Fig. 12 further illustrates this aspect. This shows sequential stages of producing electric motor rotor laminations 63 and stator laminations 66 by progressive tooling. Immediately preceding the tooling, the strip passes an infrared radiant element 59 shaped to conform to the index section of the strip.

The positional adjustment likely to be required is at most a few thousandths of an inch. With metal strip of conventional dimensions and producing components of typical size, this degree of adjustment can be produced by temperature changes within 10°C.

The above arrangements require the profiled strip to be produced with a wavelength shorter than required, so that the fine adjustment can be made by stretching or thermal expansion. It would be possible to start with a longer wavelength and achieve fine control by shortening. In principle, this could be done by cooling, but this is unlikely to be practicable in the time available. However, shortening could be achieved by

making depressions or creases in the inter-component space by means of controlled pressing, for example.

It is also possible to use temperature effects to control the accuracy of the wavelength in longitudinal slitting, to produce profiled strip to a desired standard. By varying the temperature of the cutter wheels, their effective diameter, and thus the wavelength, can be varied. Fig. 12A shows diagrammatically a pair of cutter wheels 5 with spokes 101 shaped to allow expansion and contraction of the rim. Fig. 12B shows in more detail side-cutting wheels 5 with pressure roll areas 102 provided with a non-skid surface 104. The wheels 5 are shown, for clarity, spaced further apart than they would be in use, when the material thickness between the wheels could be just less than the step height. The wheels 5 are provided with slip rings 103,105 for the connection respectively of a temperature sensor and a heating element (now shown) within each wheel. These are connected in a feedback circuit with detectors such as 7,8 (Fig. 1); suitable feedback circuit arrangements will be apparent to those skilled in the art. The cutter wheels could be controlled in diameter by other means, e.g. hydraulics or mechanically actuated wedges. As an alternative to heating the cutter wheels, the strip could be heated.

The profiled slit strip could be produced by means other than those described above; for example by laser or plasma cutting.

The invention may also be applied to feeding progression tooling or other cutting means with metal strip having periodic features other than, or addition to, profiled edges. Such features might be pilot holes, or areas of print.

Fig. 12C shows such an application of the invention. Strip 2 is passed between a roll 107 and backing rolls 108 to produce periodic features; these

may be for example printed areas or embossing. In order to maintain the spacing between features at a standard, the roller 107 is expansible by thermal, hydraulic or mechanical means as previously described under the control of a sensor 106 for detecting a related parameter of the incoming strip 2. Such parameter will normally be temperature, but feed tension may also be relevant.

The strip 2 may undergo further processing directly, or may first be reeled and stored, as indicated by the break. Fig. 12C particularly illustrates an arrangement in which the printed strip is then slit to give individual profiled-edge strips by means of shaped shearing wheels 5. To ensure precise registration of the print areas with the shaped wheels 5, the wavelength between print areas is adjusted thermally by upper and lower heaters 56 using infrared lamps controlled by a photocell monotor 50.

Fig. 12D shows a system in which printed sheet is fed directly to steerable cutting wheels in housing 23,25 to produce profiled strips 9. In this instance, the sheet 2 is screen printed against a backing member 110 by a screen 111 mounted in a holder 109. The printing is "on the fly", i.e. the screen 111 and holder 109 move with the strip 2 as indicated at F and then return in an elevated position as indicated at F'. In this embodiment, a sensor 58 is used to control the spacing between printed features by stretching the printing screen 111, for example by means of hydraulic cylinders (not shown).

Fig. 12E illustrates an arrangement in which strip 2 is printed and passed to a press tool 54 which

could be a progression tool, as shown, or a blanking tool. The printing by rolls 107,108 is controlled as in Fig. 12C to give a feature wavelength conforming as closely as possible to a standard, and subsequently fine control of wavelength is provided by elements 56-58 as before.

A further possible method of finely matching feature wavelength to tooling pitch is to mount each pair of dies (upper and lower) together with pilot punches and guide pins in a block which can be moved axially relative to the adjacent block; e.g. by hydraulic rams, screw jacks, or thermally expansible material.

Fig. 25 is a plan view of a feed means for profile-edge strip where fine adjustment of the strip is not required. The strip 9 is held vertically by guides (not shown) and is advanced stepwise by grippers 110 which cycle over the path P,Q,R,S. The grippers 110 contact the strip 9 via resiliently-biased fingers 112. The biasing may be hydraulic or by springs. The use of the biased fingers 112 acting against the sloping flanks of the strip has the effect of averaging out wavelength variations when feeding the strip.

The embodiments described thus far enable an improved material utilisation by feeding conventional progressive tooling with strip specially prepared to minimise scrap. The invention also addresses the problem of material utilisation by modifying the tooling feed to allow stock strip, which is normally several times the component size in width, to be used as will now be described.

This aspect of the invention is based in feeding the strip stepwise both axially and transversely. Fig. 13 shows strip 2 fed to a die set 67 (to be described in greater detail below) by a known feed

unit 55 mounted on a traversing carriage 68 movable transversely on a slideway 69. The coil 1 is supported on rollers 71 which are driveable (by means not shown) to produce a storage loop of strip supported on a skewable roller 70. The loop is of sufficient size to allow the required degree of movement in the transverse (x-x') direction.

Figs. 14-16 illustrate a twin feed arrangement. In Fig. 14, two forward feed units 55 are mounted on sliding carriages 68,72 running on lower and upper slides 73,74 which can be moved vertically by means 75,76 (e.g. hydraulic rams) such that feeding always occurs in a given horizontal plane, the inoperative unit being raised or lowered clear of this plane.

The apparatus of Fig. 14 may be fed from twin coils 1 as shown in Fig. 15. Alternatively, as shown in Fig. 16 the reservoir loop from the lower coil may be arranged downwardly into a pit, to reduce the head-room required.

Such twin feed arrangements may be used with the apparatus to be described to make maximum use of the strokes of the press. The two strips are fed edge-to-edge successively so that there is a minimum of unoccupied positions between the edges of the strips.

Possible uses of this XY feeding system will now be described.

Fig. 17 shows a simple case in which a die set 67 is provided with a pair of forward guides 79 and a single rear guide 80, rather than four guides in total as is conventional. The apparatus is used to produce electric motor pole laminations by appropriately shaped punches 77,78. At the start of each cycle the strip 2 is advanced by one increment Y and put in the right hand position. It is then repetitively stamped and incremented leftward as shown at X until the whole width has been stamped. The part punched out by the

punch 78 is indicated at 83. A chopper blade 81 crops the scrap and thus prevents the sideways movement of the strip interfering with the single rear guide 80. The twin-handed tooling shown could be replaced by a single row of rotatable dies to achieve the same utilisation pattern.

The X-Y feed arrangement thus allows a relatively simple die set to achieve high material utilisation from stock strip.

Figs. 19 and 20 illustrate another application. In this case the strip has to clear the left-hand side of the die set 67, which accordingly has only the forward guides 79. The strip 2 is introduced at an angle to produce optimum nesting between components. There are four punching stages:

(1) a pilot punch 85 and slot punch 86 produce a pilot hole 93 and first slot respectively

(2) a slot punch 87 forms an X-shape,

(3) a blankout punch 88 cuts out the component 91,

(4) two simple punches 84 remove the remaining material 92 which may be scrap, as shown, or a further component.

The pilot holes 93 are engaged by bullet-nosed guides indicated at 90, and the scrap cutting is so positioned that the pilot holes 93 remain for engagement by forward guides 89 on the succeeding pass. Reference 82 indicates the front profile of the strip, which is produced by the previous set of movements in the X-direction.

Fig. 18 shows a die set for use with an X-Y feed in producing a delicate component difficult to support through the stages. A punch 106 produces the aperture detail of the component 91. The outside shape detail is produced by punches 107 in a manner which

leaves a bridge piece 109 to provide additional supprt to the component. The component is finally removed by parting-off punches 108. The punches 107 can do much more work in a bi-directional system in that they act on both their approaching and departing sides in both of the feed directions. In normal practice it is much more usual to have to waste a side cutting air or scrap. They cut parts of profile at two Y stages and act at each X (in metal). As in the embodiment of Fig. 19, reference 82 indicates the front edge profile produced by the previous set of X-direction passes, the profile 82 being in this case part of the component rather than scrap.

Fig. 21 illustrates an arrangement in which the strip 2 can be indexed either in the direciton X or in the opposite direction X'. A second set of scrap punches 94 is provided, either the punches 84 or the punches 94 being activated in accordance with the direction of feed. Fig. 22 shows a similar bi-directional X-feed arrangement using a multiple ganged punch 95 together with deactivable scrap choppers 80,96 to left and right. Fig. 23 illustrates a bi-directional progressive arrangement using a first punch 97 used in either direction of feed, and pairs of blankout punches 88,100, pilot punches 98,99 and scrap cut-off punches 84,94, one of each pair being deactivated in accordance with the feed direction. Such bi-directional arrangements may be used to reduce the overall lateral space required and the time required for flyback.

Fig. 24 illustrates a somewhat different use of the X-Y feed, in that the progression of the tooling is along the main (Y) feed axis, thus allowing a more conventional die set to be used. Four guides 79,80 can be used, but these are widely spaced to allow for sideways (X) movement of the strip. This method may

be used as shown with profiled-edge strip produced as described above; it could also be applied to parallel-edge strip. The advantage of this arrangement is that a single coil of feedstock to a given capacity press can operate three times as long as would be the case with uni-directional feed. The same principle could be used in a die set having double or triple tooling in parallel along the axial direction.

The invention thus provides for significant improvements in materials utilisation which can be used in conjunction with existing presses and conventional tooling.

CLAIMS

1. A method of cutting components from continuous metal strip, comprising:

providing the strip with periodic repetitive features at axial spacings corresponding to successive component positions, and

effecting cutting of the strip in a manner closely defining the component positions;

characterised by effecting wavelength adjustment immediately prior to or during cutting to produce correspondence between the feature spacing on the strip and a length dimension of the cutting means.

2. The method of claim 1, in which the cutting means is a progression press tool, and said wavelength dimension is the pitch between successive stages thereof.

3. The method of claim 1 or claim 2, in which the continuous strip has one or both edges profiled to closely define the component positions, said repetitive features being formed by said profiled edge(s).

4. The method of any preceding claim, in which said adjustment is effected by adjusting the temperature of the strip.

5. The method of any of claims 1 to 3, in which said adjustment is effected by mechanical deformation of the strip.

6. The method of claim 3, in which the strip is produced by cutting with shaped wheels, and including controlling the diameter of the wheels in dependence on a parameter of the incoming strip.

7. The method of claim 3, in which the strip is produced by cutting with variable-orientation shears, and including adjustment of the variation of orientation in dependence on a parameter of the incoming strip.

8. The method of claim 1, in which said features are printed or embossed by printing means, and including

altering the effective length of the printing means and of said features in dependence on a parameter of the incoming strip.

9. The method of claim 6, 7 or 8, in which said parameter is temperature.

10. Apparatus for use in carrying out the method of claim 6, including pairs of profiled shearing wheels positioned above and below the strip, and means for altering the diameter of said wheels.

11. The apparatus of claim 10, in which said means comprises thermal, mechanical or hydraulic means.

12. Apparatus for use in carrying out the method of claim 7, including a plurality of pairs of shearing rollers positioned above and below the strip, each roller being journalled in a holder rotatable about an axis oblique to the strip, and cyclically operating means for rotationally and transversely oscillating said holders.

13. A method of feeding a press tool having a plurality of pressing positions starting with strip material which is of substantially greater width than the dimensions of the components to be produced, the method characterised by feeding the strip forward stepwise and, between successive forward steps, indexing the strip sideways to allow each tool to operate successively on the strip across its width.

14. The method of claim 13, in which the forward feed direction and sideways indexing direction are oblique to each other.

15. The method of claim 13 or claim 14, in which the press contains progressive tooling arranged along said sideways direction to perform sequential punching operations on each component location.

16. Apparatus for carrying out the method of claim 13, including a press tool having a plurality of pressing positions, reel stand means for holding a supply reel

of metal strip, and feed means interposed between the reel stand means and the press tool, the feed means being adapted to advance the strip stepwise in a forward direction and to translate the strip sideways in one or more steps between successive forward feeding steps.

17. The apparatus of claim 16, including a second reel stand means for handling a second metal strip, the feed means being adapted to feed the metal strips in such manner that while one strip is being indexed sideways the other strip is stepped forward and positioned with an edge adjacent the trailing edge of said one strip.

18. The apparatus of claim 16 or claim 17, in which the press tool is a die set having upper and lower members relatively movable toward and away from each other on sliding guide posts, and carrying progressive tooling dies, the direction of the progressive tooling being said sideways direction.

19. The apparatus of claim 18, in which the upper and lower members are not substantially wider than the width of the strip, a single guide post at the feed side being kept free of sheet material by the action of a scrap chopping means.

20. The apparatus of claim 16, in which the upper and lower members are provided with laterally extending portions for the guide posts such that the lateral spacing of the guide posts is substantially greater than the width of the strip.

21. The apparatus of claim 18, in which the dies have front and rear faces, with respect to said forward direction, which act in successive feed steps on front and rear edges respectively of the components, thus permitting components to be joined together in forward and sideways directions during production.

22. The apparatus of any of claims 18 to 21, in which the tooling includes at least one pair of selectively actuable dies or pilot punches, one of the or each pair being actuated for sideways translation in one direction and the other for sideways translation in the other direction.

23. A new method of cutting components from continuous metal strip, substantially as described herein.

24. A new apparatus for cutting components from continuous metal strip, substantially as described and illustrated with reference to the accompanying drawings.

DATED THIS 7 AUGUST 1985

C SLABBERT

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10 SHEET (S)
SHEET No. 1
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Fig. 1

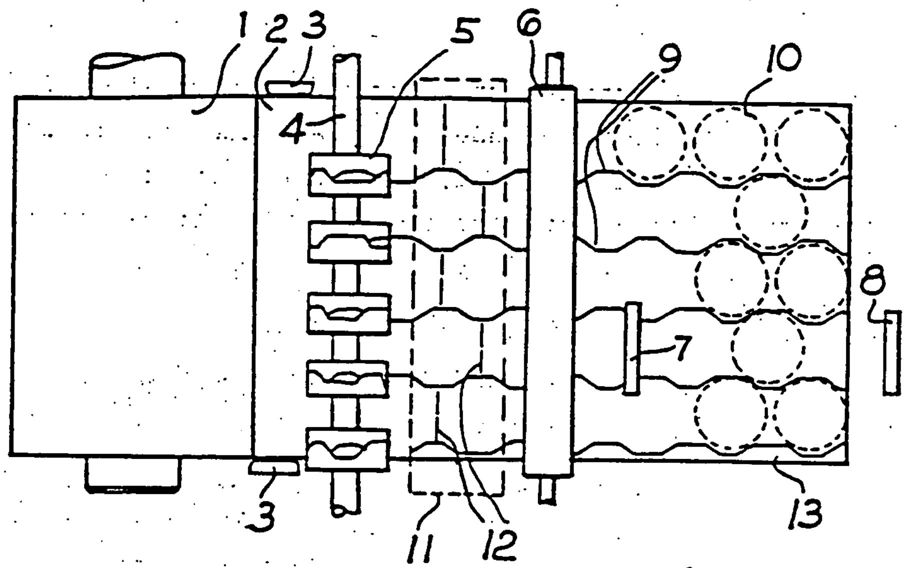


Fig. 2

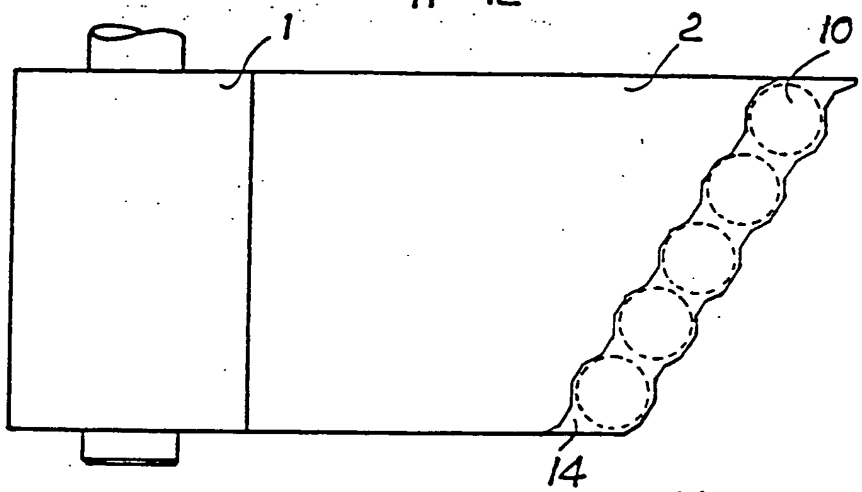


Fig. 3

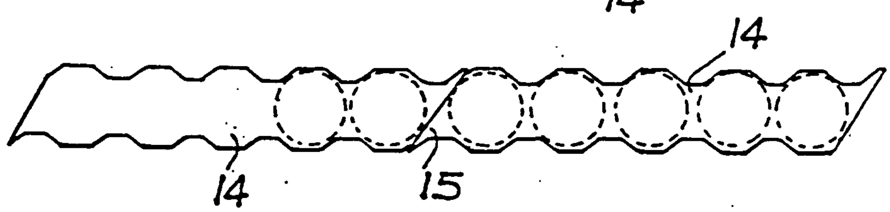


Fig. 6

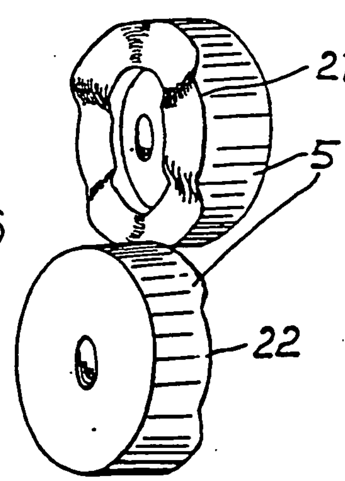
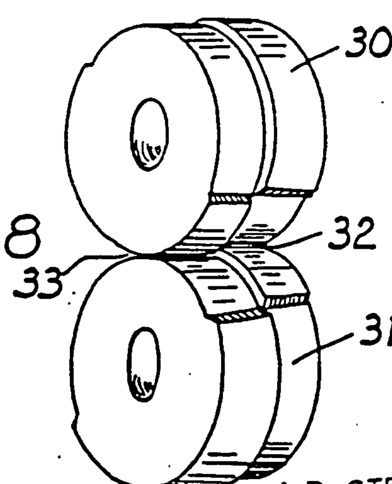


Fig. 8



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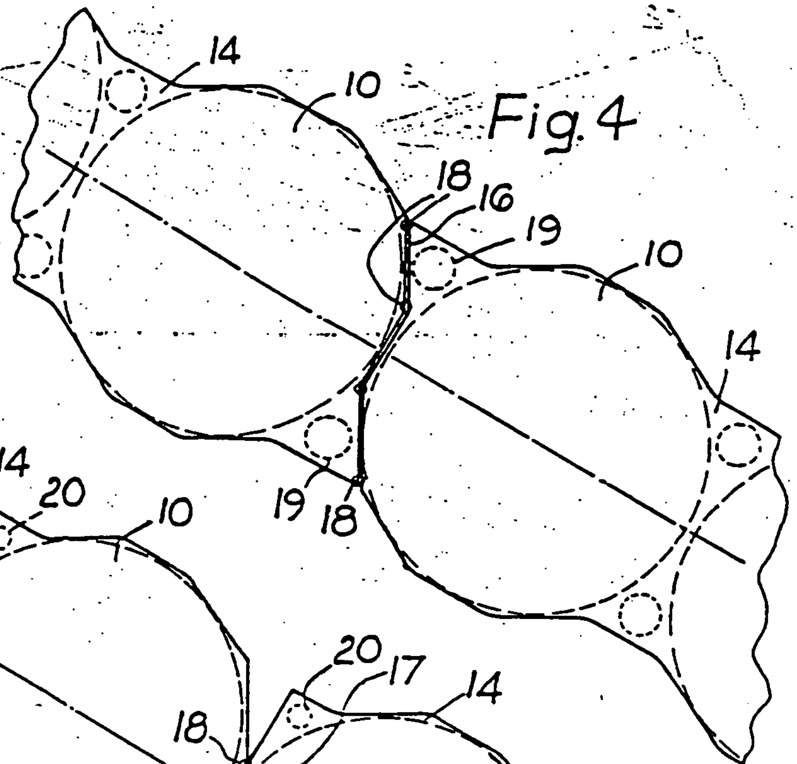

Fig. 4

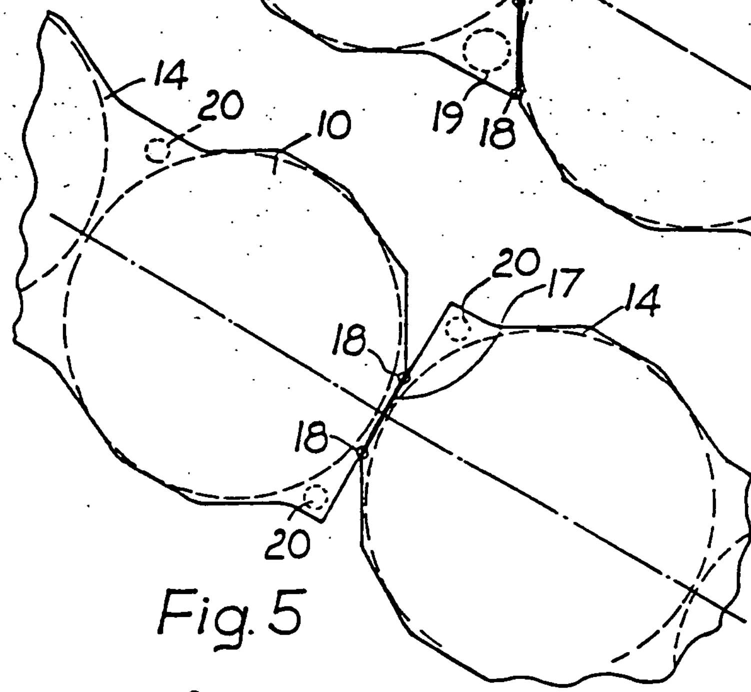

Fig. 5

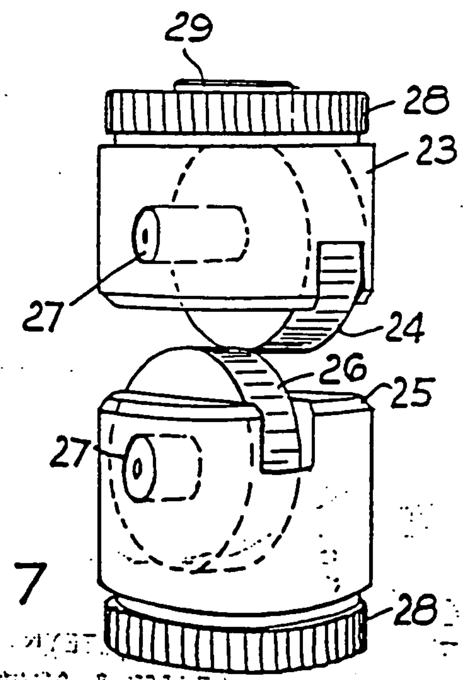

Fig. 7

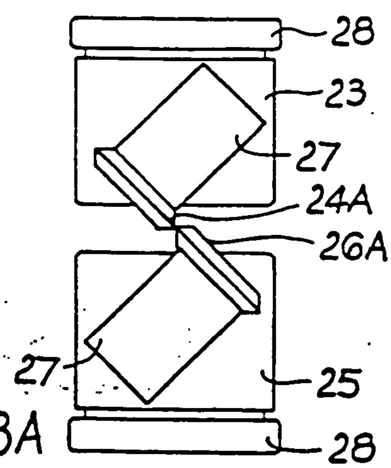

Fig. 8A

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10 SHEET (S)
SHEET No. 3
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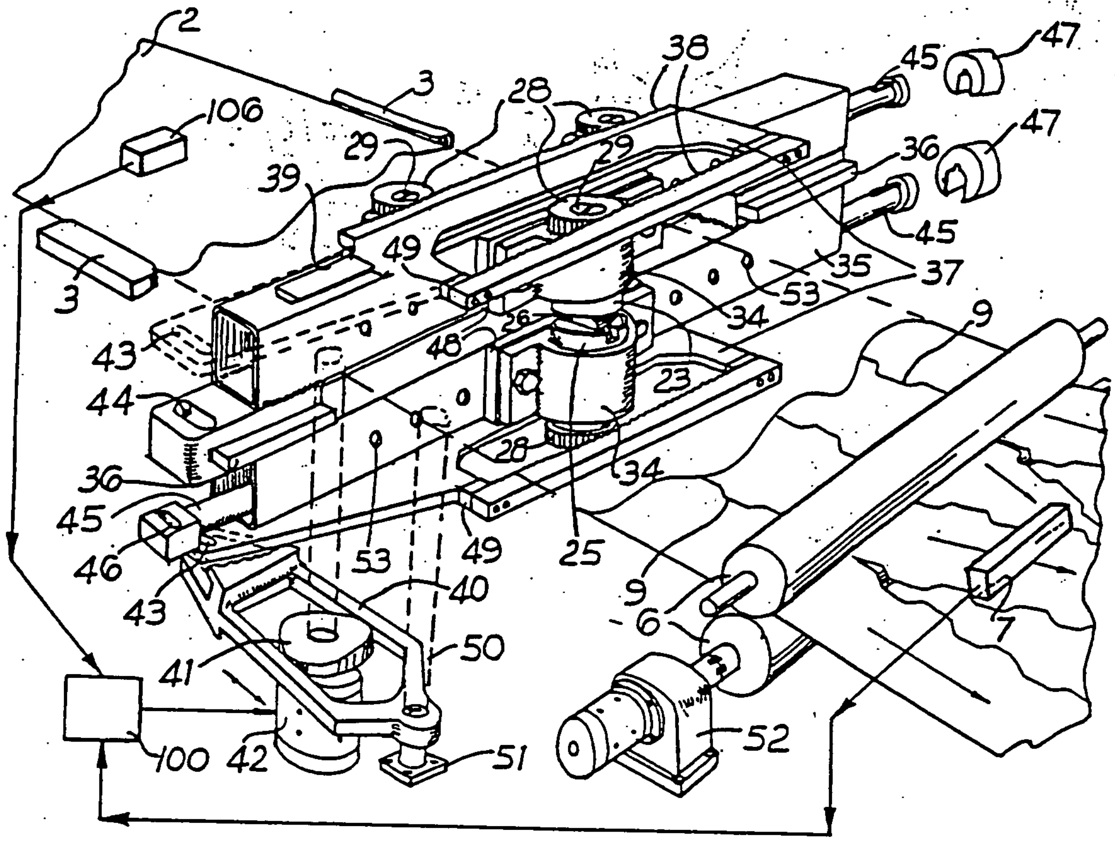

Fig. 9

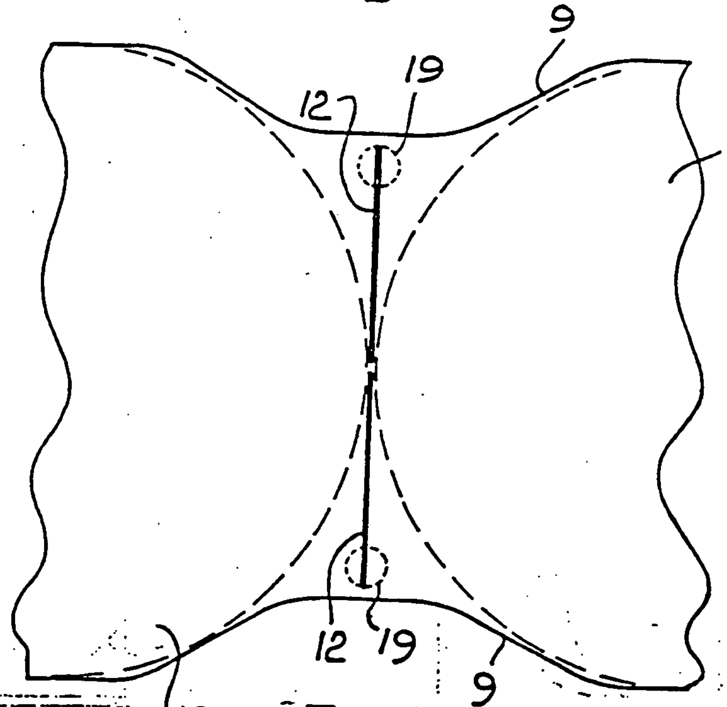

Fig. 10

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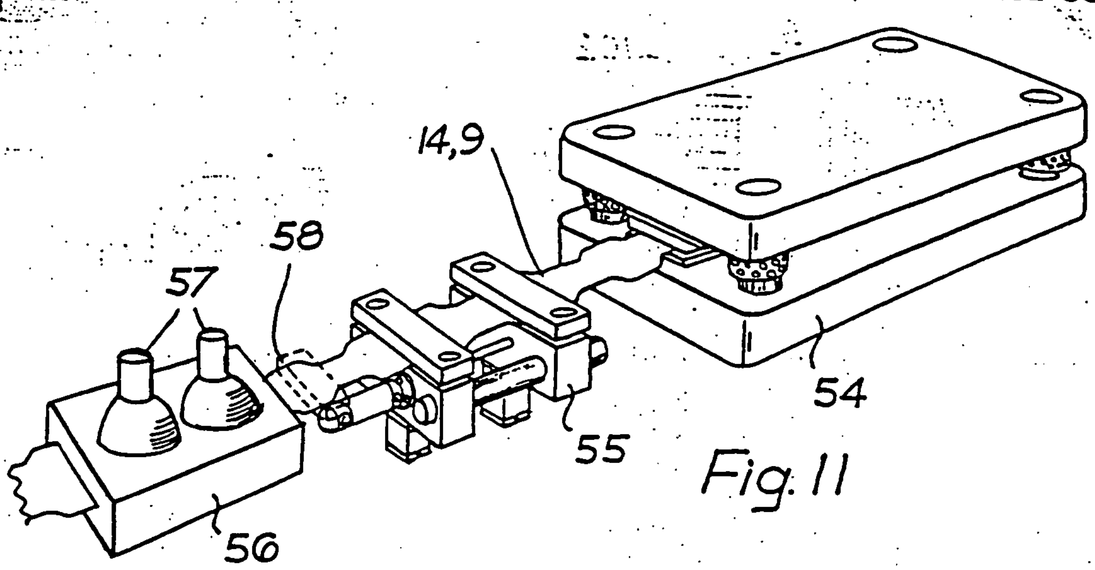

Fig. 11

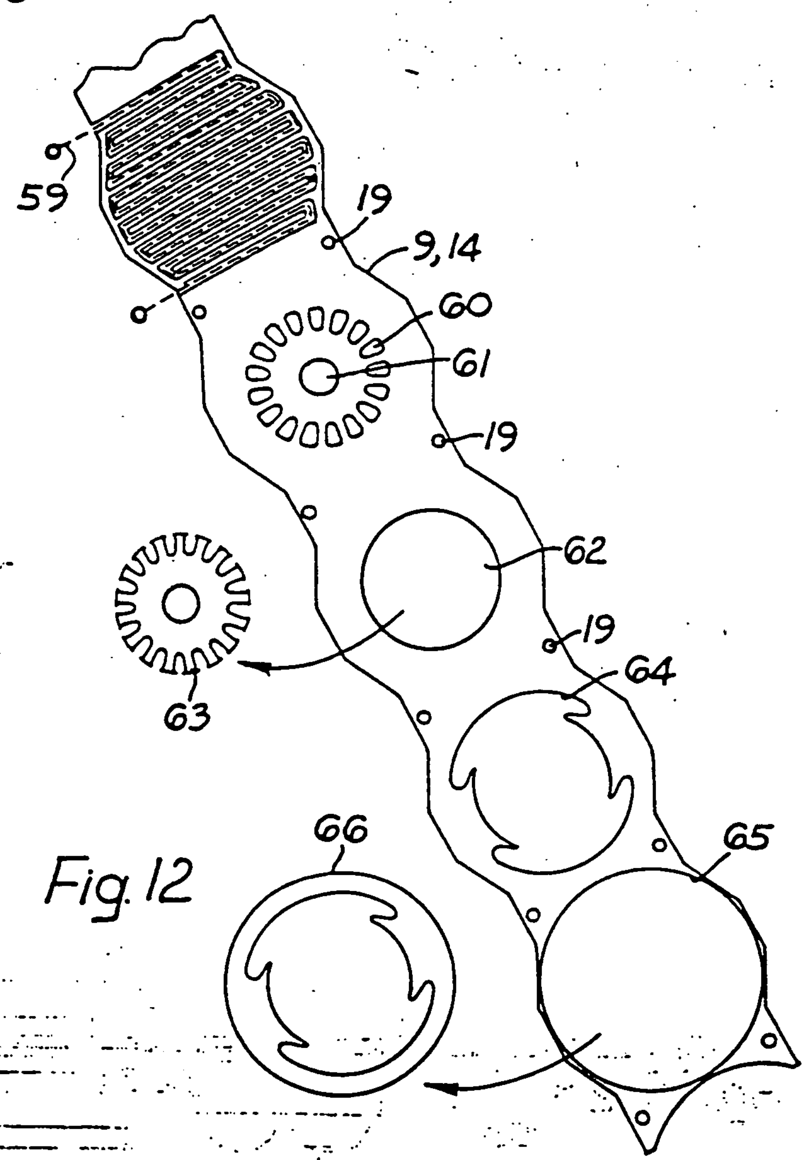

Fig. 12

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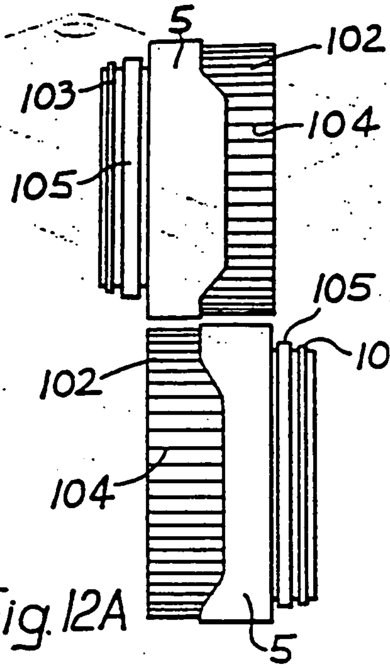

Fig. 12A

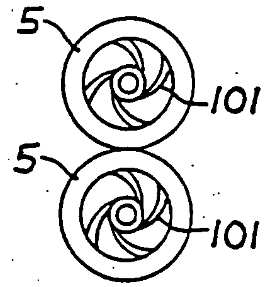

Fig. 12B

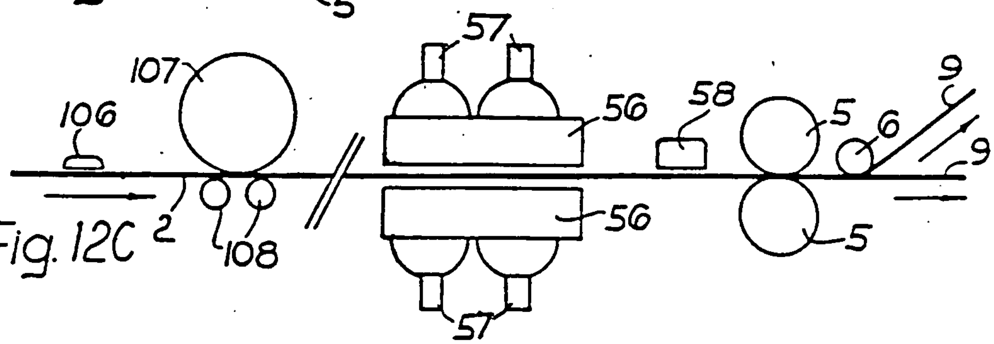

Fig. 12C

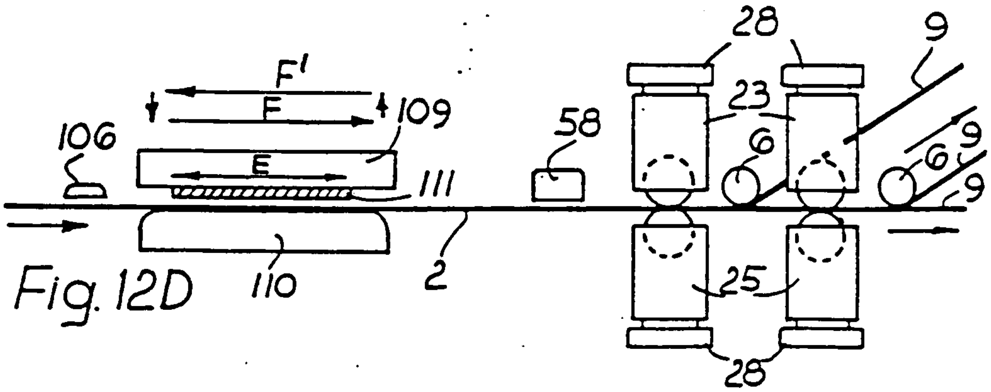

Fig. 12D

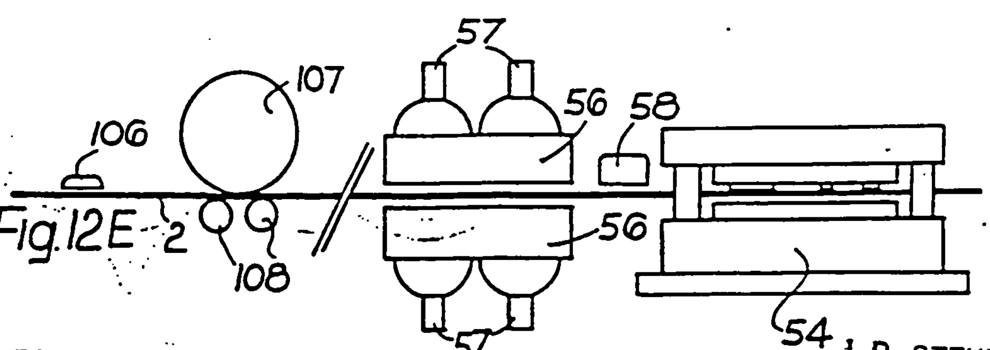

Fig. 12E

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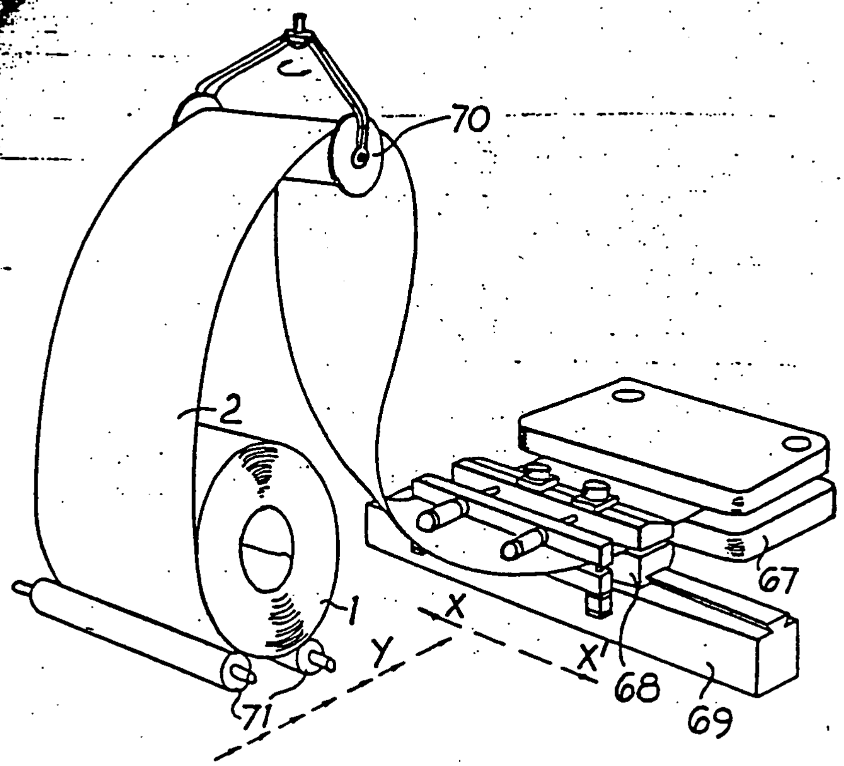


Fig. 13

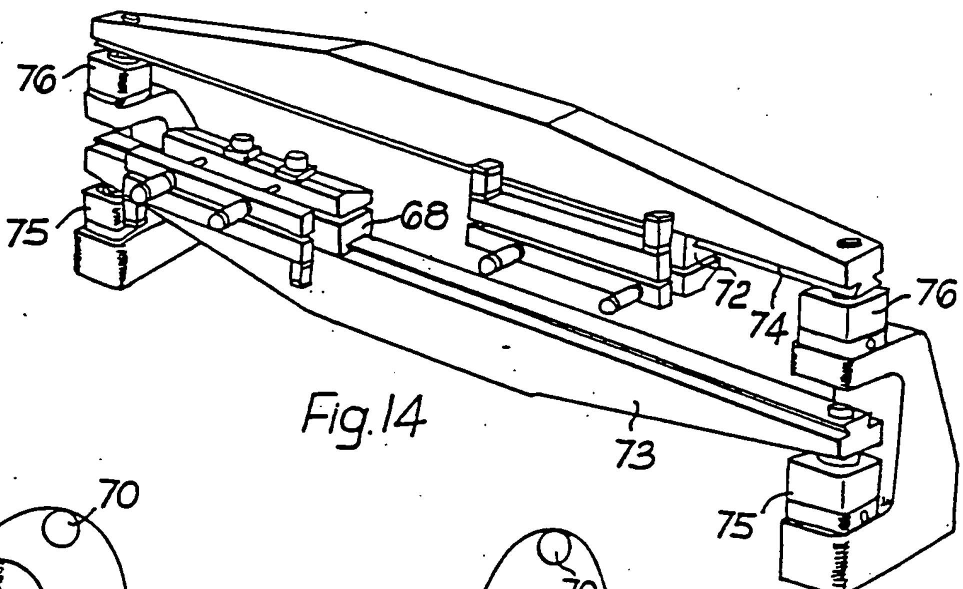
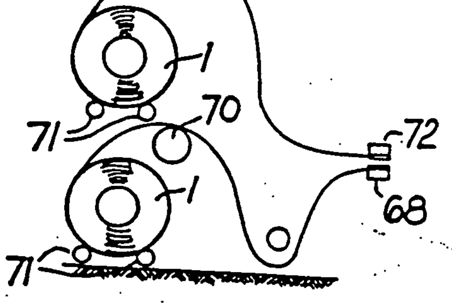


Fig. 14



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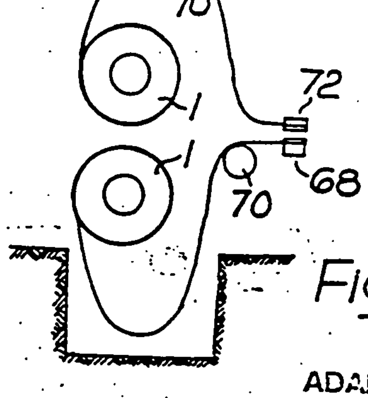

Fig. 16

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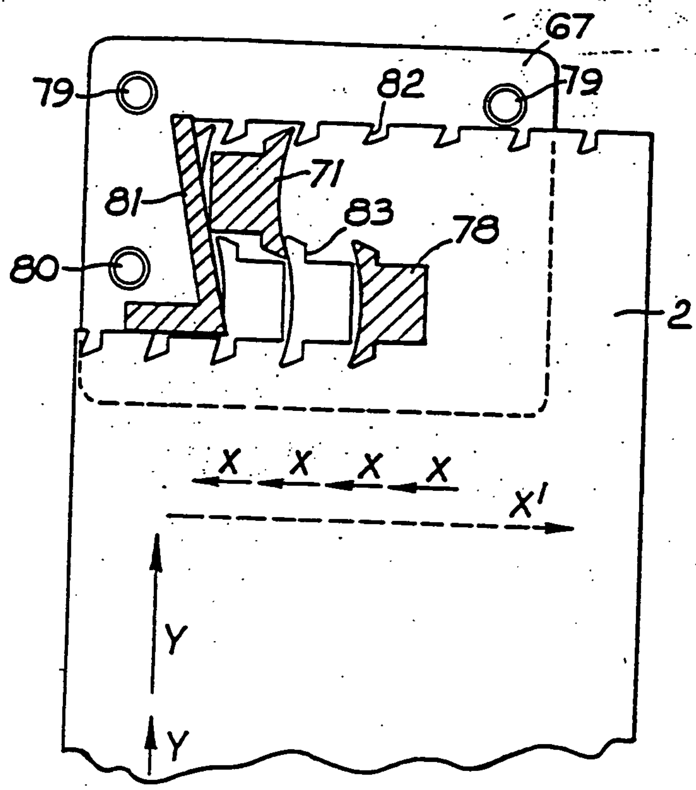
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80
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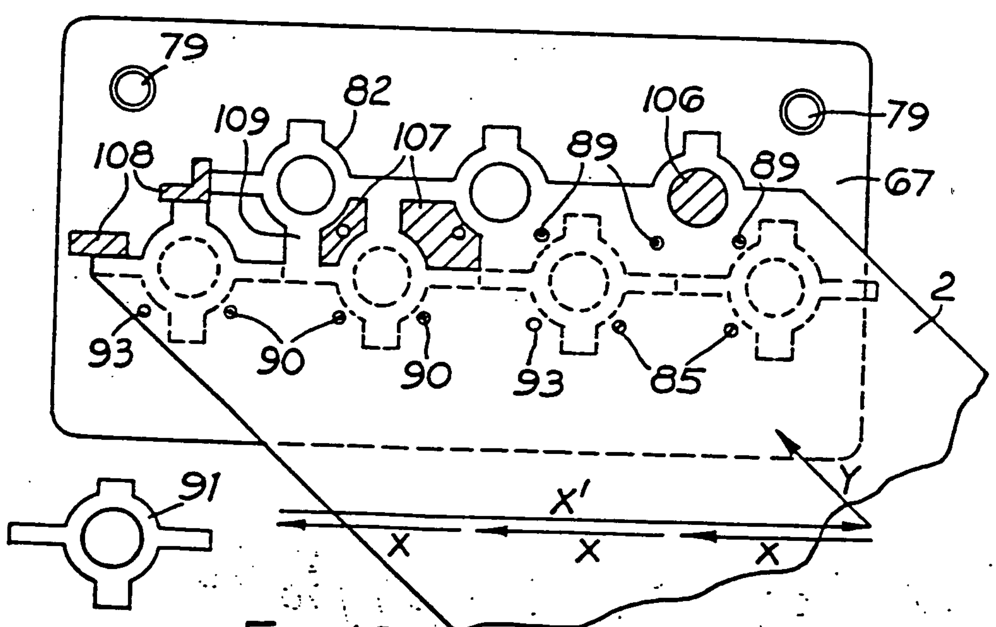
X
X
X
X
X'
Y
Y

Fig. 17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Y
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X'
X
X
X

Fig. 18

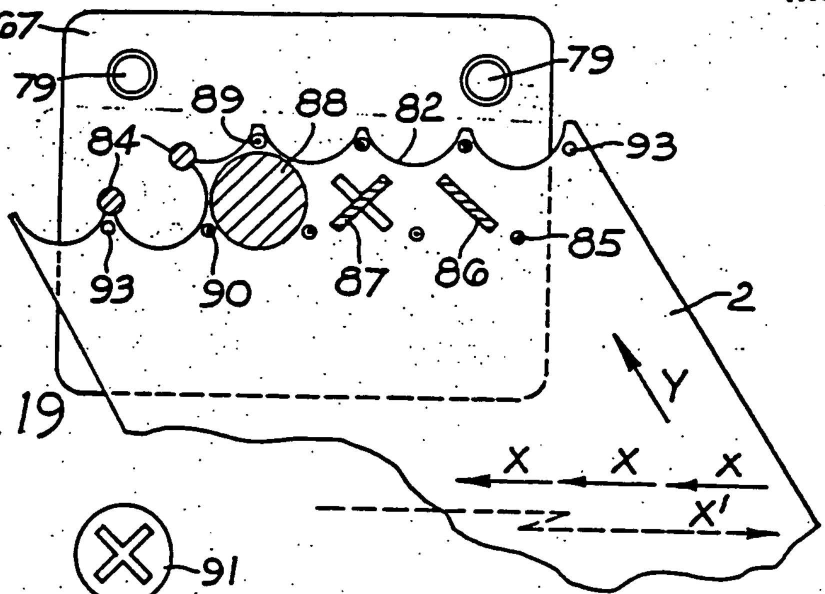

Fig. 19

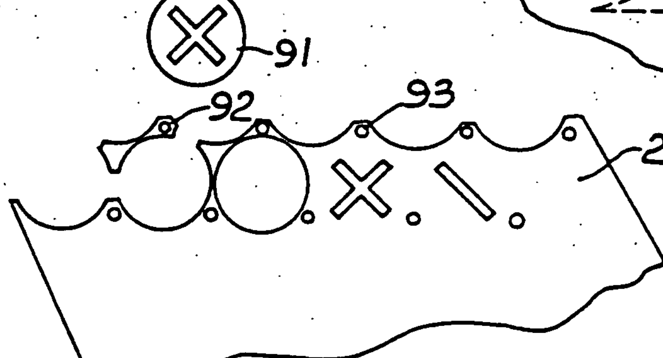

Fig. 20

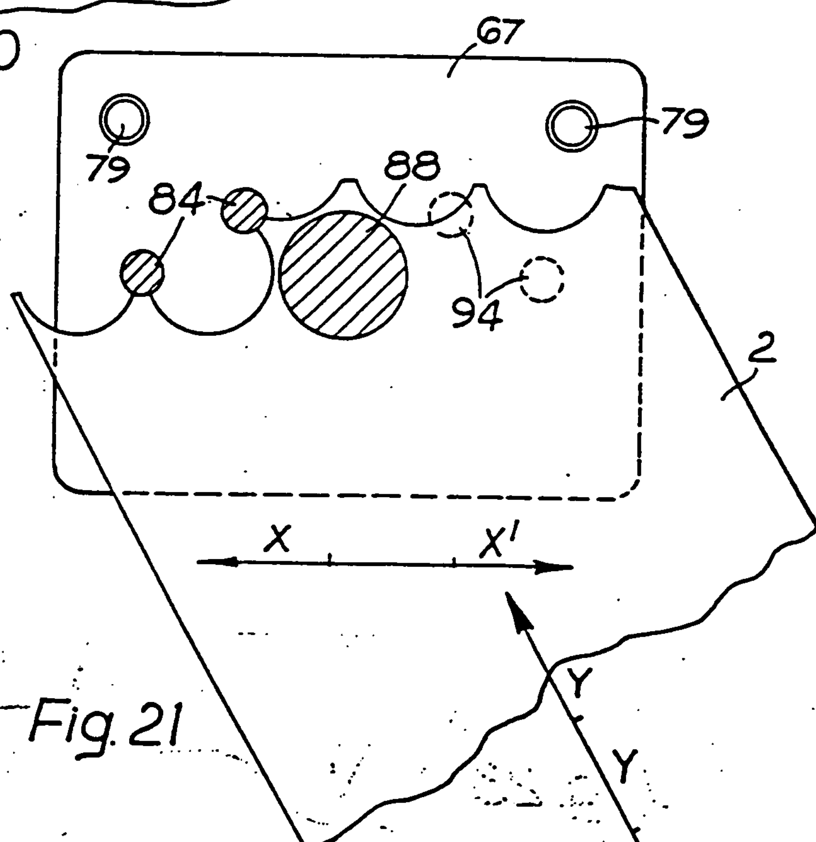

Fig. 21

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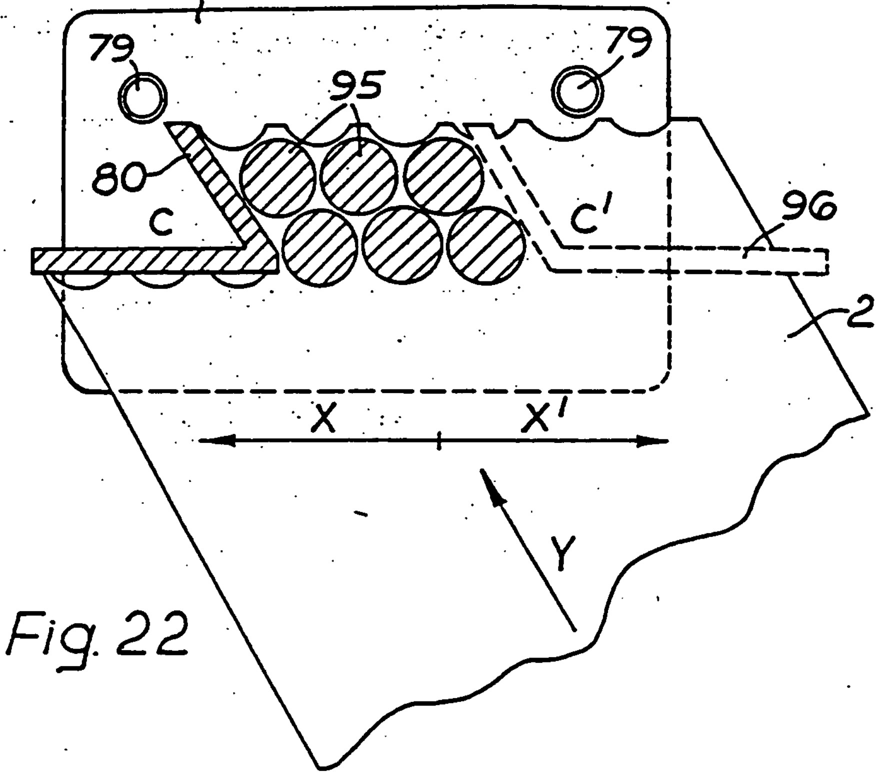

Fig. 22

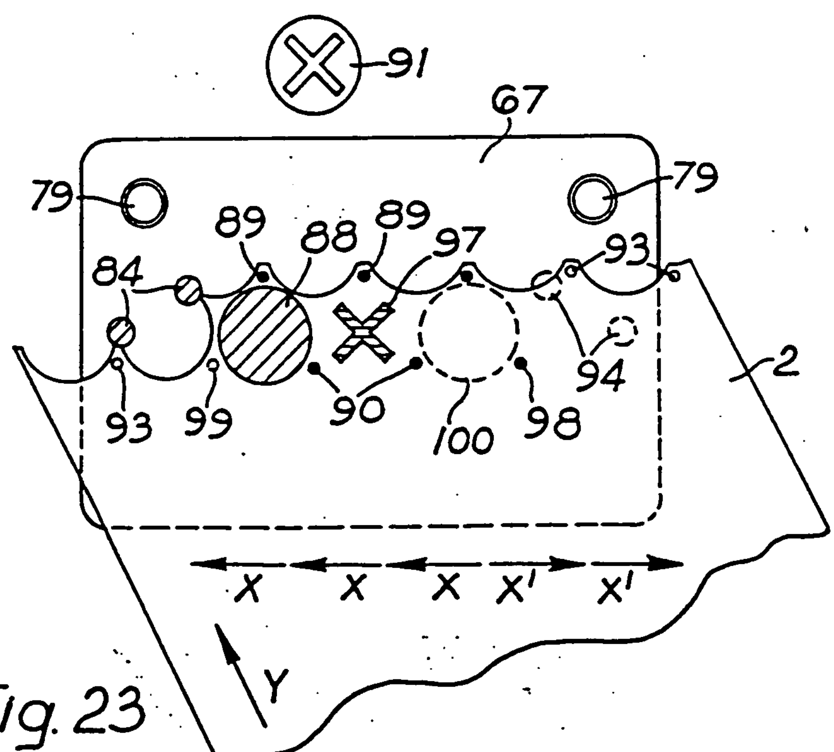

Fig. 23

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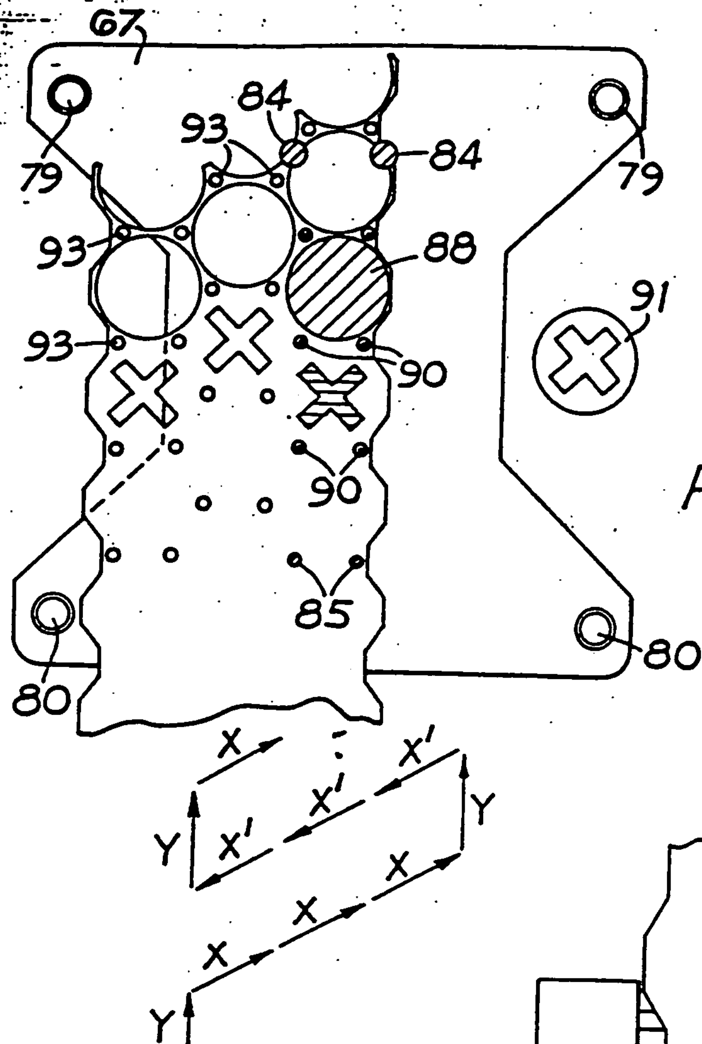

Fig. 24

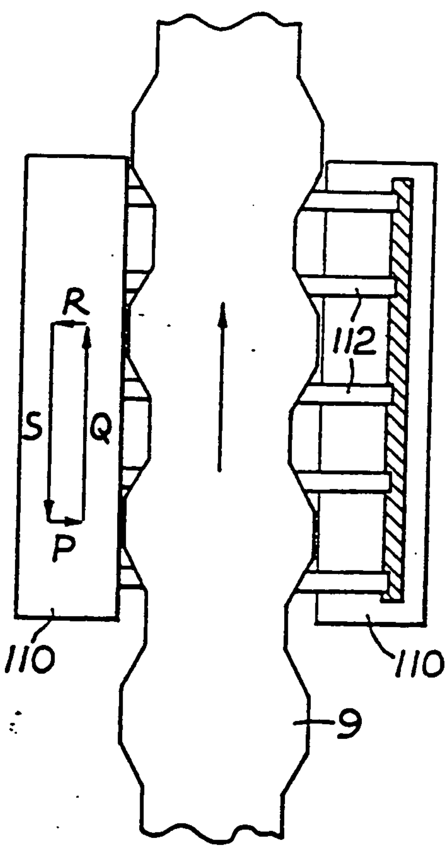

Fig. 25

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